SECOND BI-MONTHLY PROGRESS REPORT
UNIVERSITY OF ALASKA
ERTS PROJECT 110-1

November 30, 1972

A. TITLE OF INVESTIGATION:
Coordination and establishment of centralized facilities and services for the University of Alaska ERTS Survey of the Alaskan environment.

B. PRINCIPAL INVESTIGATOR/GSFC ID: Albert E. Belon/UN318

C. PROBLEMS IMPEDING INVESTIGATION:
The principal problems impeding the project are related to delayed deliveries of equipment items and heavy workload in the Geophysical Institute machine shop.

For the color additive viewers these problems are largely behind us. All system components are now on hand, except for the large specially-ordered front surface mirrors, and our machine shop is now assembling the viewers on a priority basis. It is expected that the first unit will be operational at the Geophysical Institute by mid-December, and the second unit will be shipped to Palmer, Alaska at the end of December.

For the digital color display unit, further delays are likely. The original schedule of the subcontract with Interpretation Systems, Inc. (ISI) called for delivery of the Color Display Unit (CDU-200) on October 28, 1972. Late delivery of major components delayed assembly of the CDU by about one month. Recently, ISI has informed us that various engineering problems will cause a further postponement of delivery to about December 25. Our evaluation of the situation suggests that it is unlikely that ISI will deliver the CDU system before mid-January

D. PROGRESS REPORT
1. Accomplishments during the reporting period.
a. Coordination of the University of Alaska's ERTS activities. While little ERTS data and no aircraft data were received during the previous reporting period, the flow of these data rapidly became an overwhelming flood during October and November when several hundred ERTS scenes and several thousand frames of aircraft data were received. Nevertheless we succeeded in cataloguing, filing and transmitting the incoming data to the University investigators in a timely manner.

a. - continued
Project 110-1 organized a one day ERTS session for the second annual Alaska Earth Sciences Planning Conference, held at the Geophysical Institute on November 2-4, 1972. The morning was devoted to presentations of current ERTS activities by the University of Alaska, the U. S. Geological Survey, the U. S. Bureau of Sports Fisheries and Wildlife, and the U. S. Army Cold Regions Research and Engineering Laboratory. The afternoon session was devoted to a visit of the University ERTS facilities and to working group discussions among the participants. Attendance at the ERTS session of the conference averaged about 60 persons representing major government agencies and University departments involved in environmental research.

Throughout the reporting period, personnel of project 110-1 were constantly in contact with University investigators, assisting them with the administration of their ERTS contracts, and with their data processing and analysis activities.

b. Education and training in remote sensing.
In response to numerous requests, project 110-1 will conduct an intensive short course on remote sensing applications during the period December 13 - 20, 1972. The course will be based in part on the short course given at Purdue University in July/August, 1972, and in part on the course given at the EROS Data Center in November, 1972. The Purdue course emphasized the digital approach while the EROS course emphasized photographic interpretation. J. M. Miller, co-investigator on project 110-1, attended both courses (at little expense to the project) and is responsible for planning the U of A course and selecting additional speakers.

c. Development of data processing facilities.
The ERTS data library has been operational since mid-October. It contains ERTS data catalogs and microfilms, copies of all ERTS and NASA aircraft data received by the University projects, U.S.G.S. maps of Alaska at scales of 1/1,000,000 and 1/250,000, a microfilm viewer/printer, light tables, roll film transports, magnifiers and ERTS Data Users Handbook and other remote sensing literature. A shaded-relief wall map of Alaska at a 1/1,000,000 scale provides a convenient reference for interpreting the ERTS prints.

The ERTS data library has been utilized extensively by university investigators and government agencies. It also functions well as an ad-hoc meeting place where ERTS data users coordinate their activities.

c. continued
The ERTS photoprocessing darkroom adjoins the data library so that ERTS film products can be conveniently checked-out by the photo-technician perfecting data processing techniques (as part of project 110-1) or completing work orders for other investigators. The Mark III Log-Etronic printer, acquired with project funds, is used almost routinely and it has proved to be essential for handling the remarkable, but difficult, 70mm negative transparencies provided by NASA.

Owing to the greater than anticipated utilization of the ERTS data library and darkroom, we have decided to locate the color-additive viewer in another room whose narrow and long (40 feet) dimensions will allow projection of registered color images at scales ranging up to 1/250,000, and excellent control of ambient illumination. As discussed in part C we expect the color-additive viewer to be operational by mid-December.

The ERTS digital processing laboratory has been prepared for the arrival of the Color Display Unit (CDU-200). As discussed in part C, it is unlikely that the manufacturer, Interpretation Systems, Inc., will deliver the CDU-200 before mid-January. Mr. Robert Porter, co-investigator on project 110-1, visited ISI in late October. Although the CDU was not yet in the testing stage at that time, the visit was very profitable because it afforded a timely review of the engineering design software development, and digital tapes formats and test patterns. Mr. Porter reports that the engineering design, as it finally developed, provides much greater flexibility and user interaction than it was originally envisaged. It is clear to us, after comparing the CDU with other similarly-priced systems, that we will have a far superior instrument. Our only concern so far is the unexpected considerable delay in delivery.

d. Development of photographic image processing techniques. Several typical Alaskan scenes have been utilized in the development of image processing techniques.

Scene 1009-22095 (Seward Peninsula) was reconstituted in in several false colors utilizing the Ektacolor process. Intended variations in the color balance of various prints helped to enhance specific vegetative and geologic features.

d. Continued

Scenes 1029-20383 (Big Delta), 1033-21020 (Mt. McKinley) 1055-21270 (Aleutian Peninsula), 1081-20275 (Tetlin Lake), and 1049-20505 & 1103-20513 (Anchorage) were color-reconstituted using the 3M color-key process. Portions of scenes 1033-21020, 1055-21270 and 1049-20505 were also enlarged at scales up to 1/250,000 and color reconstituted by the color key process. In the color key process we are now using a 200 lines screen which provides a spatial resolution approximating that of the ERTS data. In general reconstituted color infrared utilizing the complementary colors yellow, cyan and magenta for MSS bands 4, 5 and 7 is the most useful combination for distinguishing vegetation types; however the use of primary colors or a combination of primary and complementary colors sometimes provides striking enhancements of particular features. For example superimposing band 4 (yellow) band 5 (cyan) band 6 (magenta) and band 7 (blue or black) enhances contrast and brings out new vegetation in old burned areas. This combination applied to scene 1033-21020 brings out the morains and snow line on glaciers and aids in the identification of surging glaciers and glacier-dammed lakes. On the other hand a low contrast and reconstituted color infrared from bands 4, 5, and 6 appears to be best to identify kelp beds on scene 1055-21270 and to trace sedimentation patterns in coastal areas. Because of its great versatility and the ability to view images simultaneously in individual bands and in color-composites, the 3M color-key process is likely to supplant the ektacolor process and the dye-transfer process as analytical tools in much of our work. It also rivals the use of a color-additive viewer because its much lower initial cost, convenience of operation, and superior registration and geometric fidelity.

Scene 1103-20504-7 (Brooks range) contains much subtle detail as well as an extreme range of densities in various parts of the scene. It was printed by various techniques including logE printing. It is clear from these tests that no single printing technique can be used as a standard. The density scale modulation of the logE printer is invaluable when highlight and shadow detail must be both preserved, but, when either one is sought, straight printing with contrast control is favored. Because of its fine detail this scene was also used to determine the relative visual information content of various enlargements ranging from 3.3x (1/1,000,000) to 67x (1/50,000). The optimum enlargement depends, of course, on the size of the area of interest and the finesse of detail, density range and contrast within that area. For some small areas 67x enlargements are useful as working prints; however, on the average, 13.5x (1/250,000) enlargements are optimum because little if any improvement in visual information content is provided by greater enlargement.

d. Continued
Numerous other scenes were printed to test our photographic reproduction techniques on a variety of negative and positive transparencies. These include scenes 1002-21310, 1018-21200, 1037-21234, 1039-21371, 1043-20163, 1062-20221, and 1063-20280.

3. Development of computer programs for digital processing of ERTS data. During the second reporting period a number of computer programs have been written, debugged and implemented for use in digital data processing.

In early October three programs were completed relating to the generation of test tapes for the digital Color Display Unit being built by Interpretation Systems Inc. of Lawrence, Kansas. "CDUTESTT" generates a tape with 16 test patterns, primarily geometric in nature, which are designed to assist in the debugging and testing of the CDU, and includes all patterns requested by ISI plus several patterns of our own design. "LISTCDUT" produces a hexidecimal listing of a CDU tape and also checks that all records are of correct length and that each file has the correct number of records. Since it was desirable to supply test tapes to ISI from both of our 9-track tape drives on our 360, "COPYCDUT" was written to copy CDU tapes.

One set of digital tapes containing real data has been received from NASA (MSS scene 1002-21310). Several general purpose programs have been written which use MSS tapes for input. The above mentioned tapes have been used for checkout of these programs. "ERTSLMSS" will list an MSS tape, providing a neat labeled listing of the scan lines which are selected by a control card. "ERTSCONV" converts a portion of a MSS tape to a tape suitable for display on the CDU, which is being constructed to display a 512 x 512 picel picture. Control cards allow for the selection of the scan line to start with, the indentation of the starting picel, if any, and the band to be converted.

"ERTSLCDT" provides a totally different form (different than "LISTCDUT") of listing of a CDU tape. Each picel is represented by one character, and the "picture" is printed in four strips of 128 characters each. When these four strips are attached together, the result is a "picture" about 51 x 85 inches, representing one 512 x 512 picel "picture". A special feature of this program allows the assignment of any character to each density (intensity level).

These programs and the software being provided by ISI for use with the Color Display Unit provide all of the basic software required to select scenes from the NASA-provided MSS tapes and to display these scenes either on the 360's printer or the CDU. A third test tape, containing an actual ERTS scene, has been forwarded to ISI to provide another means of checking the CDU, in this case with an actual scene.

e. Continued
All preparations for the CDU are thus now completed and we are now eagerly awaiting the delivery of the CDU which is scheduled for the latter half of December.

During the third week of October, Mr. Robert Porter visited ISI in Lawrence, Kansas for three days to discuss the CDU. At that time software for the CDU had been written and debugged as far as possible on the PDP-11 which was up and running. The Kennedy tape drive and Xebec controller had been attached to the computer and were operating, but with some difficulty in reading the tapes provided by the University, probably due to minor skew alignment problems. Several special features were discussed in detail. Additional "read-only" memory will be provided by ISI so that the core memory of the PDP-11 can be dumped onto the magnetic tape unit, and, of course, read back in. This program entry into the CDU should be much more convenient than through the very slow mechanical paper tape reader. This feature will greatly facilitate the developement and use of a repertoire of programs on the CDU. The second extra feature will provide a means of "flickering", with a variable rate, between two pictures stored on any of the three disk channels. One possibility for use of this feature is to provide a means of visually detecting subtle differences between bands.

The delivery of the CDU is now quite a bit off of the original schedule, but it is hoped that the many features being supplied by ISI will justify the long wait.

2. Plans for the next reporting period.

a. Coordination - These activities will continue at a somewhat higher level of effort because a semi-annual progress report and a revised data handling plan are due at the end of the next reporting period.

b. Education and training - A remote sensing short course on the applications of remote sensing data will be given during the period December 13-20, 1972. Consultations with investigators and graduate students involved in the U of A ERTS program will be held throughout the period.

c. Establishment of data processing facilities - The color - additive viewers constructed in our shops will be completed and installed in Fairbanks and Palmer during December.

The digital color display unit will be installed by the manufacturer during January. We hope that it will be available for use by investigators within a few days of its installation.

d. Development of photographic image processing techniques. - We feel that this phase of project 110-1 activities is nearly over.

d. Continued
Many of the techniques which we have developed or perfected are now in use by the University investigators on the basis of specific work orders (which are charged to individual projects). During the next reporting period we plan to bring into operational use two additional techniques: color photography of false color images displayed on the color-additive viewer, and density slicing by the photographic agfacontour process.

e. Development of computer programs for digital analyses of ERTS data.
This activity will be emphasized during the next reporting period, particularly if the digital color display unit is delivered by the manufacturer about January 1, as is presently scheduled.

E. SIGNIFICANT RESULTS (See separate pages)

F. PUBLICATIONS: None

G. RECOMMENDATIONS: While we appreciate and recognize the magnificent achievement of NASA in producing 70mm negatives which have very fine grain and an extreme range of densities, these negatives are very difficult to work with, particularly for summer scenes which contain both strong highlights and shadow detail. Therefore we endorse NASA's tentative plans to produce two sets of negatives, and we suggest that the full density range negative be on 240mm format and the smaller density range negative be on 70mm format.

H. CHANGE IN STANDING ORDER FORMS:
Original order date: 6/20/72
Revised order date: 11/7/72

I. ERTS IMAGE DESCRIPTOR FORMS:
Image descriptor form is attached. It is also mailed separately to ERTS Users Services.

J. ERTS DATA REQUEST FORMS:

Submitted on	22 August 1972	(data received)
	24 August 1972	(data received)
	31 August 1972	(data not received)
	13 October 1972	(data partially received)
	9 November 1972	(data not received)
	9 November 1972	(combined with data query-data not received)
	21 November 1972	(data not received)
	24 November 1972	(data not received)

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TITLE OF INVESTIGATION: Coordination and establishment of centralized facilities and services for the University of Alaska ERTS survey of the Alaskan environment.

DISCIPLINE: Interpretation technique development.

SUBDISCIPLINE: Thematic mapping.

Scene 1009-22095 (Western Seward Peninsula, Alaska) has been studied from the point of view of vegetative and geologic mapping as part of our objectives to develop ERTS data processing and interpretation techniques. Individual bands were studied from 9.5 inch prints and projected 70mm positive transparencies. Composite color-infrared prints were made from MSS bands 4,5, and 7 using the Ektacolor process and varying the color balance to enhance specific features.

The vegetation analysis was conducted in cooperation with project 110-3 and revealed seven major color differences which were interpreted to represent shrub thicket, upland tundra, coastal wet tundra, alpine barrens, grassland tundra, senescent vegetation and tundra burn scars. The first four types are well described by existing vegetation maps, although the ERTS scene shows that the shrub thicket exists not only in the southern part of the scene as vegetation maps indicate, but also throughout the western part as a pattern following stream beds. The last three vegetation types are not represented on existing vegetation maps.

The geological analysis was conducted in cooperation with project 110-13. In general the result of this analysis agreed very well with existing geologic and tectonic maps with two exceptions. The ERTS scene analysis could not differentiate between small outcrop of rocks which the geologic maps identified either as granite intrusives or as metamorphic rocks. On the other hand the ERTS scene revealed a dumbbell-like drainage pattern inthe northern part of the same geologic pattern. The geologic map shows only the right part of the dumbbell and identifies it as a granitic intrusion which is in fact seen on the ERTS scene as a small outcrop. No outcrop is seen at the center of the left part of the dumbbell, but the drainage pattern suggests that a buried granitic intrusive may be present. This is quite significant because tin deposits on the Seward Peninsula are found in these granitic intrusions.

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DISCIPLINE: Interpretation technique development

SUBDISCIPLINE: Image enhancement techniques

Scene 1029-20383 (Big Delta, Alaska) was selected for enhancement studies because much ground truth is available and the scene represents a broad range of terrain types: wilderness mountain areas, glacial and clear water streams, cultural features, and some rare agricultural activities in the interior of Alaska. The scene was studied in detail using false color composites produced by the 3M color-key process, a color-additive viewer at the EROS Data Center, and a digital display unit at South Dakota State University. In general the three techniques achieved the same results qualitatively, but once the features and subtle differences were recognized with the photographic techniques, the use of digital techniques and color-coding capabilities afforded a superior degree of enhancement.

The reconstituted color images discriminate very well between the clear water of streams draining watersheds with vegetative cover from the turbid water of glacier-fed rivers. It is also possible to differentiate shallow water from deep water in lakes of varying depth. Old forest fire burns are very well revealed in false color enhancement, not so much because northern ecology is slow to heal but in this case because a different type of vegetation, aspen and birch, grew to replace the original habitat of black spruce which existed fifty years ago. Apparently the rehabilitation and change of vegetative cover after natural or man-made disturbances occur will be easily monitored by space data over very long periods of time.

This scene reveals that prevalent winds raise a column of dust and sand, 2 km wide and up to 50 km long, from the dry wash bed of the Delta River and cause a severe air pollution problem in an area which may be subject to development in the near future.

Finally a characteristic dashed and zig-zag line in old terminal moraines suggests that the Mt. Hayes glacier, which is now retreating, was once a surging glacier.

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

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ID

DATE November 30, 1972

PRINCIPAL INVESTIGATOR Albert E. Belon

GSFC U318

ORGANIZATION Geophysical Institute, University of Alaska

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS		
	Mtn.	Tundra	Rivers	Coast,	Snow	
1002-21310	X	X	X			lake
1009-22095	X	X	X	X		lagoons
1018-21200	X	X	X			lakes
1029-20383	X	X	X			highway
1033-21020	X	X	X		X	glaciers
1037-21234	X	X	X			forest burns
1039-21371		X	X	X		sedimentation
1043-20163	X		X		X	glaciers
1049-20205	X	X	X	X		city
1062-20221	X		X		X	volcano
1063-20280	X		X		X	volcano
1081-20275	X	X	X		X	lakes
1103-20504	X	X	X		X	fault
1103-20513	X	X	X	X	X	city

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)